N. C. AGRICULTURAL EXTENSION SERVICE

OF THE

STATE COLLEGE AND

STATE DEPARTMENT OF AGRICULTURE AND

U. S. DEPARTMENT OF AGRICULTURE COOPERATING

B. W. KILGORE, DIRECTOR

RALEIGH

EQUIPMENT FOR MAKING SORGHUM SIRUP

By M. W. HENSEL, Agent in Sugar Plant Work

DISTRIBUTED IN FURTHERANCE OF THE ACTS OF CONGRESS OF MAY 8 AND JUNE 30, 1914

EQUIPMENT FOR MAKING SORGHUM SIRUP

By M. W. Hensel, Agent in Sugar Plant Work

With proper care and much labor a very good grade of sorghum sirup an be made with crude tools and machinery; but a much better grade an be produced, and with much greater economy of material and labor, y the use of good and well arranged equipment.

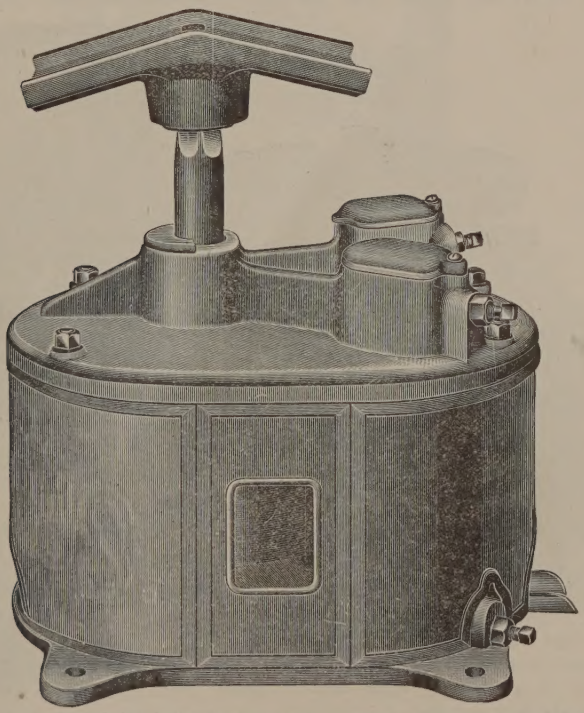

Figure 1. A Three-Roller Mill with Lever Cap on Shaft Sweep for Animal Power

It is the purpose of this circular to give a brief description of the machinery and utensils necessary for the manufacture of sirup in a small factory for the supply of the individual farm home, or on a larger scale for a neighborhood, or community factory.

No attempt is made here to describe the equipment for a large commercial mill, its requirements being about the same as for the smaller

factories, except that it is on a larger and more extensive scale. Manufacturers from whom supplies and equipment are purchased usually furnish plans and full specifications for the large factory, both for machinery and buildings.

MILLS

For the economical production of sorghum sirup, the mill should be of a size and type to extract the greatest possible amount of juice from the stalk. Between 70 and 80 per cent of the weight of a sorghum stalk is water but it is not possible to obtain all of it as juice. The ordinary two-roller mill will not extract more than from 25 to 40 per cent of the weight of the stalk as juice, but with a good three-roller mill, closely set and evenly fed, 60 per cent and more should be obtained. If the crop

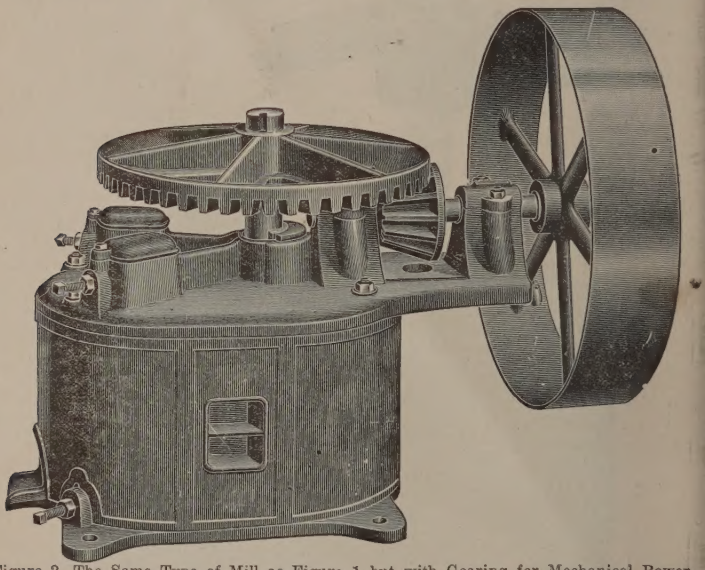

Figure 2. The Same Type of Mill as Figure 1 but with Gearing for Mechanical Power

is over-ripe and the stalks hard and dry it is difficult to secure as much as 50 per cent even with a good mill. Some two-roller mills are still in use, but on account of their low extraction and consequent wastefulness they should be discarded.

The small three-roller mills may be had with rolls set either vertical or horizontal. The rolls themselves may be either smooth or serrated. The serrated rolls in a vertical mill prevent the stalk from turning sidewise as it is fed into the mill. Nearly all of the vertical mills are operated by horse power, but some are made so that either single or double gearing may be attached for other power. Figure 1 shows a three-roller vertical mill with lever cap on shaft for attaching a sweep for

orse power. Figure 2 gives a view of a three-roller vertical mill with earing for the attachment of mechanical power. With rolls set in a orizontal position it is much easier to maintain an even and uniform eed, which is essential to perfect extraction of juice, than with the rolls

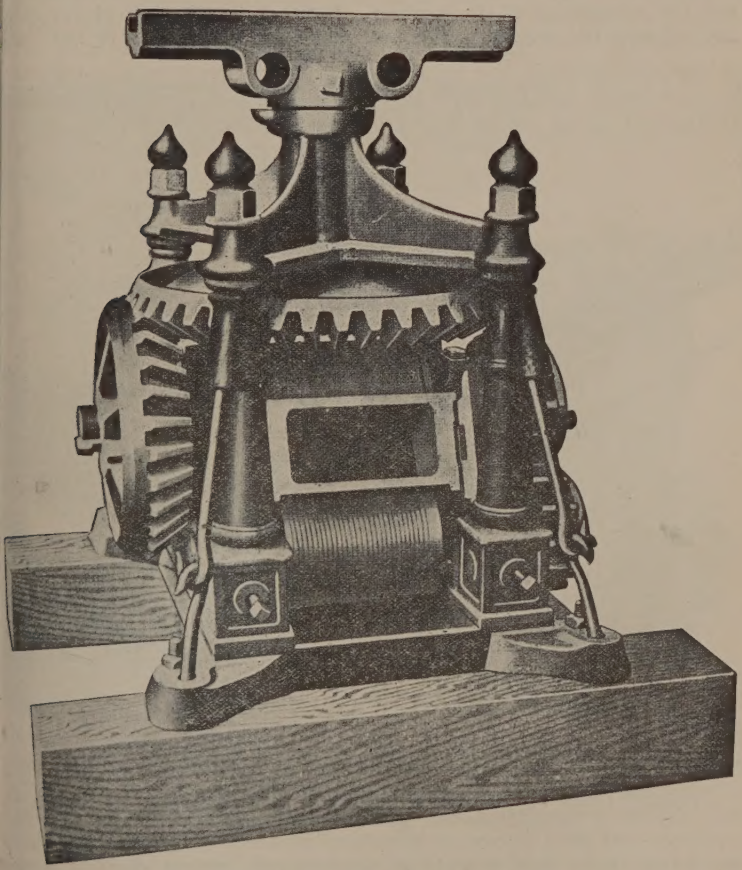

Figure 3. A Three Roller Horse-Power Mill with Rolls in Horizontal Position

in a vertical position. In Figure 3 is shown a three-roller horse-power mill with rolls in a horizontal position.

Mechanical power of some kind, such as a tractor, is now available on nearly every farm. This should be utilized for driving the sorghum mill. It is preferable to the horse-driven mills for easy and quick work. In Figure 4 a view of a power mill with feed table and bagasse carrier may

be seen. Both of these are valuable adjuncts to a mill. The feed tabl permits an orderly arrangement of the canes before entering the rolls which gives a more even feed. The bagasse carrier saves labor by carry ing the crushed stalks away from the mill. Both the feed table and th bagasse carrier are so arranged that they may be raised or lowered t suit the convenience of the operator. Figure 5 is a picture of the sam mill without the bagasse carrier and feed table. This type of mill ma

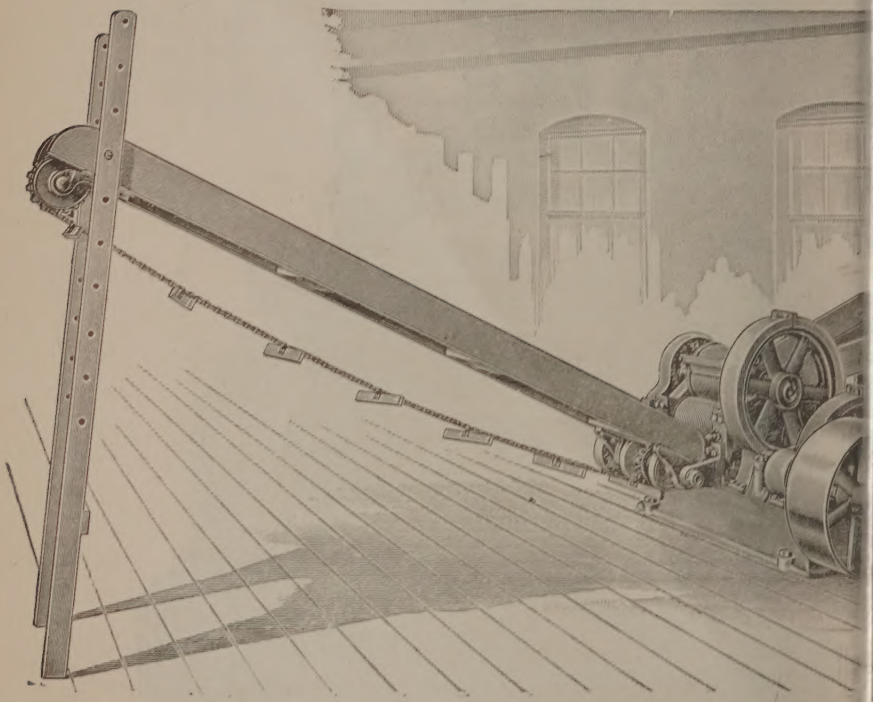

Figure 4. A Very Desirable Type of Power Mill. It Has Feed Table and Bagasse Carrier Attached. Both Attachments Save Labor

be had in three, four, five and six horse power with a capacity of 90 gallons of juice for a day of twelve hours for the small size to 3000 gallon for the six horse power. This would give from 115 gallons of sirup fo the smallest to 375 for the largest per day. Some of the larger mil are equipped with a carrier and self-feeder, the cane being thrown on th carrier which feeds it into the rolls.

Mills may be had of almost any size, from one horse-power or les up to any power desired with a capacity of many tons of cane per hou Many of the medium sized mills have a two-roll crusher attachmen

rough which the canes are first fed. The crushers work under sufficient ressure to rupture the juice cells and extract part of the juice and then elivers the cane in smoooth even layers to the full width of the rolls. his type of mill gives a very high extraction of juice when properly set. igure 6 illustrates this type of mill.

ADJUSTING THE ROLLS

Whether the mill is a large one or a small one every effort should be nade to operate economically and to obtain the greatest possible amount f juice from the ground stalks. To do this care must be exercised in

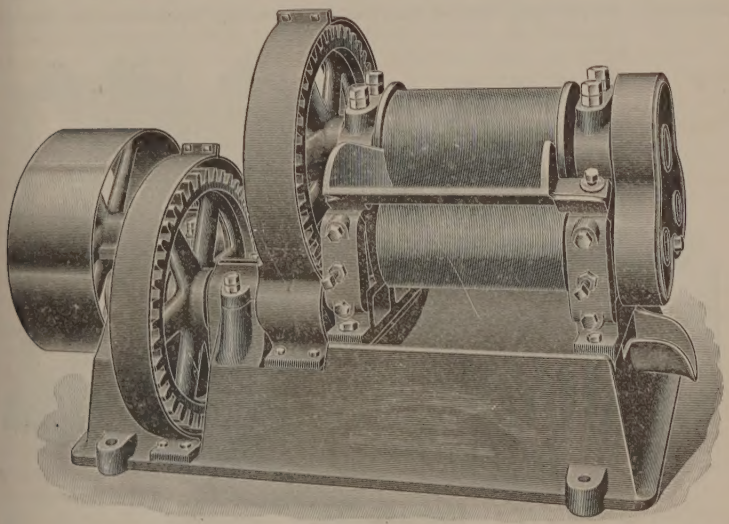

Figure 5. The Same Mill as Figure 4 Without the Attachments. These Mills Are Highly and Strongly Geared so That Their Extraction Is Thorough

adjusting the rolls and in feeding the mill. In a good mill the rolls are easily adjustable to any required distance from each other and must be exactly and evenly set for best results. With a three-roller mill the first small roller should be set from one-fourth to one-half inch from the large roller, as it is intended only to mash, not to grind the cane. The second small roller should be set up close against the large roller, but not too tight. If too tight the bagasse will be ground to fine particles and is liable to choke or even break the mill.

FEEDING THE MILL

The feed should be light or heavy according to the adjustment of the rolls. If the rolls are well apart the feed should be heavy; if they are set close together the feed should be light; but it should always be even

and uniform on the rolls. With rolls set apart a light feed causes waste of juice. With the rolls set close, and uneven feed, or an irregular layer of stalks between rolls, prevents sufficient pressure on some of the mass and consequently gives a low extraction.

SMALL PORTABLE MILL VS. LARGE MILL

The small mills, often portable, are not as efficient as the large and permanently located mills. The extraction cannot be as perfect with a small mill as with a large one, nor can a small mill work up a crop of considerable size as fast as it should be milled for best results. With a small mill, proper settling tanks, and other necessary equipment for cleans-

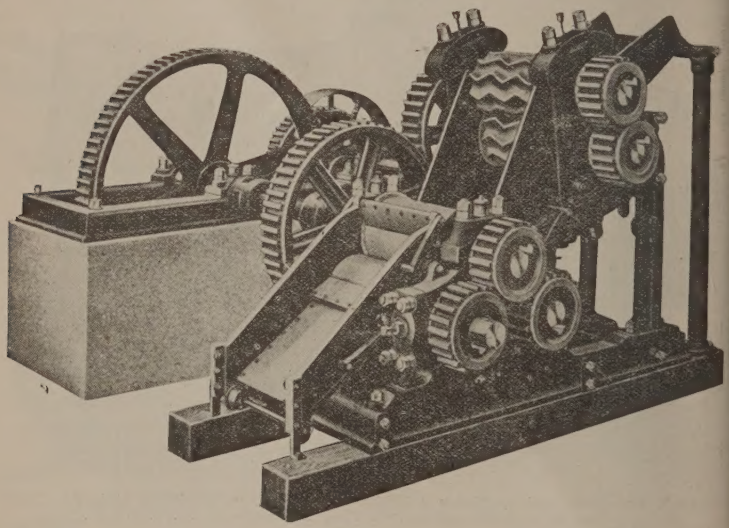

Figure 6. A Mill with Two-Roll Crusher Attachment. One of the Best Types of Mill if Sufficient Power Is Available

ing juice and for making a first-class sirup are seldom furnished. Low extraction and lack of efficient equipment should be sufficient argument against the general use of the small mill. In a community with a radius of four or five miles it is much better to have one large mill, permanently and conveniently located and fitted out with settling tanks and other apparatus for producing a high quality sirup, than to have two or more of the small mills without equipment. The large mill can be operated by an expert sirup maker and will serve the whole community in a more satisfactory way than several small mills. The larger and more efficient mills can now be bought for very reasonable figures. In the past there has been too much of a tendency to buy small mills, chiefly on account of cheapness. The heavier mills will pay for themselves in a comparatively

hort time in the saving of juice alone by reason of the greater percentage f extraction that may be had with them. They also save time and abor charge, as much more cane can be worked with them in any given eriod. The purchase of a heavy mill will be economy in the end—at east one that is heavier than may be driven with animal power.

CLEANSING THE JUICE

On leaving the mill the juice should strain through a sieve or screen of some kind to remove particles of stalk, trash and dirt and pass on nto a settling tank. For a small mill barrels may be sufficiently large for settling tanks, but for a larger mill tanks may be made of wood, concrete, or galvanized steel. For thorough settling at least two tanks are necessary, but three are still better. One tank can be filled while the other is being emptied, but this gives too little time for settling. With a third tank ample time may be given for thorough settling of the sediment in the juice. The raw juice contains many impurities which slowly settle to the bottom when allowed to stand. If this matter is permitted to enter the evaporator much of it will settle to the bottom at the point of entrance and is liable to burn there. If it is cooked into the sirup it causes a cloudy appearance and injures the flavor.

Cleansing by Heat. Heating the raw juice tends to hasten the settling of the impurities. A small boiler or a feed cooker is often used for heating juice where the evaporator is operated by direct heat, but exhaust steam is generally used where the evaporation is done by means of steam. Whatever the source of the steam, it passes through steam coils placed inside and passing through the settling tanks. When heat is used for defecation, as soon as the temperature of the juice reaches the boiling point, or when the scum breaks, the heat should be withdrawn and the green scum thoroughly skimmed off. The juice should then be allowed to stand for from one-fourth hour to an hour to settle. The clear juice is then drawn off to the evaporator. To be effective, the settling tank must be equipped with some means for drawing off the clear juice without disturbing the settlings. One of the best methods for doing this is by means of a swing pipe placed inside the tank. The pipe should be controlled by a float in such a way as to keep the upper end, or intake, just under the surface of the liquid, thus leaving the sediment behind. The arm when standing erect must reach above the surface of the liquid. The swing pipe should be close to the bottom of the tank and far enough from the side to permit the arm to lie flat on the bottom when turned down entirely. The threads of the arm should be sufficiently tight to prevent it from dropping down of its own weight.

Cleansing by Filtering. If settling tanks are not used for cleansing the juice it should, by all means, be filtered before it enters the evaporator. In fact a combination of the two methods is of great value, as the more of the impurities that may be removed from the juice outside the evaporator the better the sirup will be. In case the two methods are used in combination, the juice should first pass through the filter and then to the

settling tanks. A very good filter can be made by filling a barrel or a tight box with clean straw (preferably rye straw), or with clean timothy or marsh hay or even crushed sorghum stalks. The draw off of the filter should be from one to two inches from the bottom. The juice in passing through the filter slowly will deposit much of its sediment upon the straw or on the bottom of the receptacle. Such a filter should be thoroughly cleansed and furnished with a new filter bed at least once a day, and with a heavy flow of juice once each half day.

Cleansing by Lime. Some manufacturers cleanse the juice with lime. This is done by making a thin white-wash of freshly slaked lime. Strain this through a mesh screen of not less than one-eighth inch to remove lumps. Add enough of this solution to the juice to almost neutralize the acidity and stir well. The acidity is tested by dipping a piece of blue and a piece of sensitive red litmus paper in the solution. If it is acid the blue litmus paper will turn red and the red litmus will remain unchanged; if the solution is alkaline the blue litmus does not change while the red turns blue. If neither one changes the solution is neutral. There should, however, be enough acid left in the juice to give a faint red to the blue litmus paper. If it does not change color at all, it is evidence that too much lime has been used and fresh untreated juice should be added. Too much lime makes the juice alkaline. An alkaline juice produces a sirup very dark in color and poor in flavor. When the proper amount of lime has been added, as determined by the tests with litmus paper, the liquid should be allowed to stand for from ten minutes to an hour before drawing off to the evaporator.. Many makers are skeptical of the value of lime as a cleansing agent, although they recognize its value as a neutralizing agent where the juice may be excessively acid, and believe that treatment with heat in settling tanks is more valuable and less liable to injure the sirup.

Other Methods of Cleansing. There are a number of other methods of cleansing in use, such as with whiting (carbonate of lime), special clays, and chemicals. Since the use of these, particularly chemicals, is not advisable in small mills, these processes will not be described here. *The sirup maker should always keep in mind that in order to make a high grade sorghum sirup some effective method of cleansing the juice must be used.*

EVAPORATORS

Vat. From the settling tank the juice should flow directly into the evaporator, or into a storage tank that supplies the evaporator. There are a number of types of evaporators, the simplest of which, aside from the iron kettle now but little used, is the box, or vat. This is merely a box, usually about 8 or 10 feet by 3½ feet and from 10 to 15 inches deep, lined with galvanized sheet iron, tin, or copper, and set over an arch of iron, brick, or stone. In principle, it is only the adaptation of one large vessel for several small kettles. In using such a vat, as with an evaporator, it should be so placed on the furnace that the heat will come in

ntact with the entire bottom surface. Very good sirup can be made th such an outfit provided a single charge is concentrated without add- g fresh juice after the liquid begins to boil. The addition of fresh ice to the boiling liquid will cause the sirup to be very dark in color and rong in flavor.

Pan. One of the most common and successful types of evaporators is shallow pan, about five or six inches deep, the sides being wood and ottom copper, tin, or galvanized iron, set on a furnace. These pans may ave any surface desired, but are usually 44 inches wide and from 10 to 20 eet long, according to the size of the furnace and the capacity of the ill. Figure 7 gives a view of such an evaporator set on a rocker portable rnace. The surface of the pan is separated into different compartments y partitions with gates at the end of the partitions to control the flow f juice. In some the bottoms are corrugated, in order to supply a greater

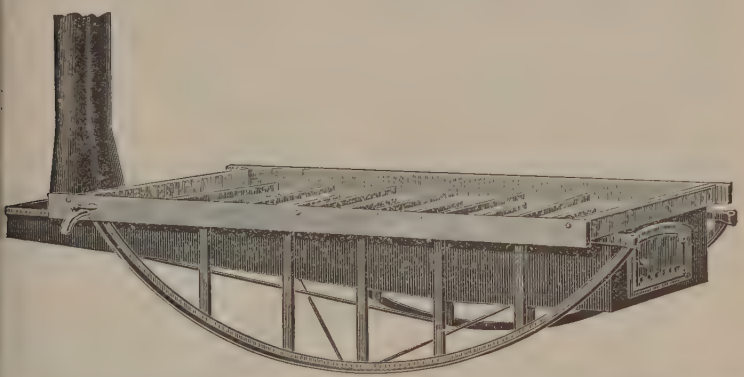

Figure 7. This Is a Small Size of the Most Common Form of Evaporator. This Style May Be on Any Size or Type of Furnace and Is the Best to Use Where Direct Heat Must Be Used for Cooking

heating surface. The juice flows in at one end and follows a zig-zag course, directed by the partitions, through the whole course of the pan. While passing over the surface of the pan it is being evaporated by the direct heat of the furnace and flows out at the other end as finished sirup. This is undoubtedly the best type to use where steam is not available and where wood is plentiful and cheap for fuel.

Steam Evaporators These are of different styles and types, all of which are good when properly operated. In one style the bottom is level and smooth, the bottom being a heavy sheet of copper riveted to a corrugated steel base. The steam passes through the open spaces of the corrugations and thus comes in contact with the whole under surface of the pan. A wood jacket covers the bottom to keep cold air from coming in contact with the heated steel and thereby lowering the steam pressure. The top of one side of this evaporator slants outward and on

this side is a scum trough. The slant makes it easy to rake all the scum into the trough. This pan has an outlet for the sirup at one corner. Figure 8 shows this evaporator. It may be placed on trestles of any height to suit the operator. In this, as with the direct fire vat, it is necessary to concentrate a single charge in order to secure good sirup, but a smaller pan may be had into which the partially concentrated sirup is drawn for finishing and the large pan re-filled with fresh juice. This is one of the very best types of steam evaporators. Another and more common type of steam evaporator is a coil of pipe in either a cylindrical

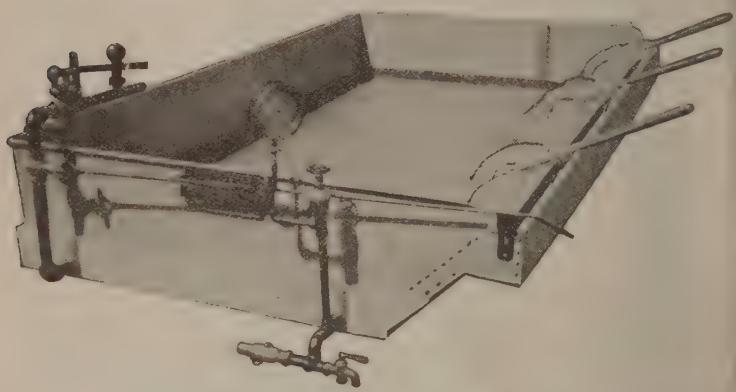

Figure 8. One of the Best Types of Steam Evaporator. The Bottom Is Covered with Wood to Prevent Cold Air from Cooling the Steam in the Corrugated Passages

tank or in a long metal-lined trough, the latter being preferable. Figure 9 represents this form. In the illustration one section of the coils is elevated to show that they may be removed for cleaning. There are several different types of the steam coil evaporators, some of which are so arranged as to keep up a continuous flow of juice over the coils and then into another section, or trough, from which it is drawn off at one end as a finished sirup. In this style the rate of flow is regulated by the pitch of the troughs.

With any form of steam evaporator there is much less danger of burning and thus spoiling the sirup than with direct heat. It is also much more economical, particularly where steam power is used for driving the mill. The methods of sirup making on a steam evaporator are in general, the same as with direct heat. The level of juice should not be over half an inch to an inch above the coils for quick evaporation and a well flavored sirup.

Vacuum Pans. These are used only in mills of exceptionally large capacity and need not be discussed here.

OTHER EQUIPMENT

Furnace and Boiler. The furnace and boiler to be used in a sirup factory are largely matters of choice. There are many different kinds that will answer the purpose satisfactorily. If bagasse is to be used for fuel, the furnace should be adapted for burning direct from the grinding mills in order to save labor. The horse-power to be developed will depend upon the combined demands of the rolls, defecators, evaporators, and other equipment of the factory.

Hydrometer. Every factory that makes sirup for a stated price per gallon or for a share of the product should be provided with either a Brix hydrometer and tube or with a Baumé instrument for testing the density of the juice. The Brix hydrometer is an instrument with a graduated

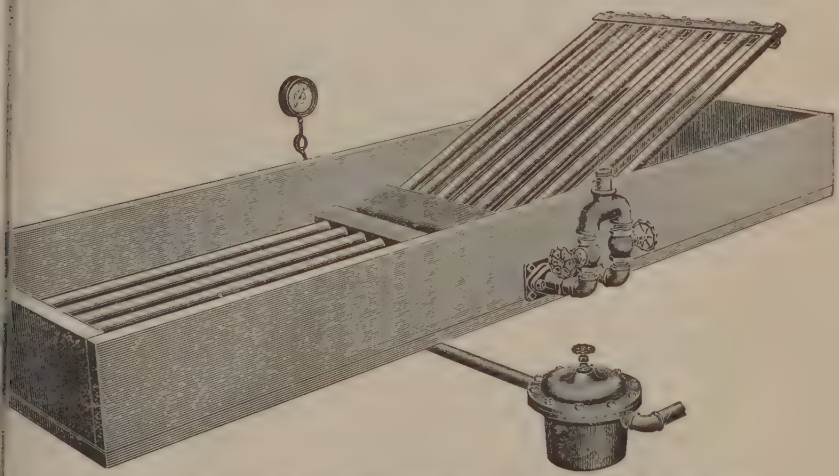

Figure 9. A Very Common Type of Steam Evaporator. The Coils May Be Removed for Cleaning

scale for measuring the percentage of solids in a liquid. In a well strained and well settled sorghum juice practically all the solid matter is sugar. To make a test, a tube, which usually accompanies the instrument, is filled with the strained or filtered juice and allowed to stand for a few moments to permit the air bubbles to escape. The hydrometer is then placed in the juice but should not be read until it comes to complete rest. The number of degrees shown on the scale at the exact level of the top of tube is the percentage of solids, or in the case of sorghum juice, of the approximate sugar content. For scientific accuracy the temperature of the liquid at the time the reading is made should be considered, but for practical purposes this is not necessary. In this climate during the sirup season the temperature of raw juice as it comes from the mill, or shortly thereafter, will not vary greatly. The quotient of 100, using 100 as a base, divided

by the reading of the hydrometer gives a very close approximation of the number of gallons of juice necessary for a gallon of standard sirup of 11¼ pounds. For example, if the Brix reading is 20 degrees, five gallons of juice will make a gallon of sirup.

If the number of gallons of juice from any crop is known and the sugar content as measured by the hydrometer, the number of gallons of sirup to which that crop is entitled may be measured out and delivered to the owner without the necessity of his waiting for the evaporation of his crop. Where settling tanks are used the quantity of juice can easily be measured. If the tank is oblong or square, multiply the inside dimensions in inches, length and width, together and divide the result by 231, the number of cubic inches in a gallon, and the result will be the number of gallons for each inch of depth. With a rule find the number of inches of juice in the tank. Multiply this figure by the gallons per one inch of depth and the result will be the number of gallons of juice in the tank. To find the capacity of a circular tank, square the diameter expressed in inches and multiply this figure by 0.7854; divide the result by 231 and the result is the gallons of juice for each inch of depth.

The Baumé hydrometer has a different scale from the Brix, but tables may be secured or worked out from which the number of gallons of juice for a gallon of sirup may be determined.

Thermometer. A thermometer for determining the finishing point of the sirup should be provided for every factory that desires to make a uniform and standard product. This is the most exact and practical test of the finishing point that can be applied in open pan evaporation. The thermometer should be accurate and should register not less than 228 degrees Fahrenheit. It should be tested in boiling water and the point registered there by the mercury carefully noted. The boiling point of sorghum sirup that will weigh from 11¼ to 11½ pounds to the gallon is from 12 to 13 degrees above that of water. In using the thermometer care must be exercised that the bulb does not touch the sides or the bottom of the evaporator. It is well to fasten the thermometer by some sort of clamp to the side of end of the evaporator in the finishing, or sirup, end so that it can be easily read at any time. When it registers from 12 to 13 degrees above the boiling point of water it should be drawn off at once.

Skimmers. Two or more skimmers should be provided for each evaporator, the number depending on the size of the pan. One skimmer should be used in the green or juice end of the pan and the other in the sirup end. They should not be used back and forth from one end to the other without thorough cleansing. Figure 10 shows a good type of skimmer. It should be about seven inches long and five or six inches wide and made of tin or copper. It should have sufficient small perforations to permit the quick passage of juice but still retain the scum and sediment.

Header. Some sort of a device for cutting off the heads of the cane at the mill should be planned. A knife attached to a heavy lever similar to the old time feed cutting box will answer the purpose and will save much labor and time.

Storage Tank. There should be a tank to receive the finished sirup of size to take care of the capacity of the evaporator. If possible it should so arranged that a stream of cold water may pass around it to cool the rup. Many sirup makers think that a quickly cooled sirup holds its color nger. The tank should have a screen strainer for the admission of the rup so that no flies or other insects can possibly gain admission. It is most impossible to filter sorghum sirup satisfactorily, nor is it necessary do so if the juice has been properly cleansed, if utensils have been kept ean, and other precautions taken to prevent the entrance of foreign sub- ances during the process of manufacture.

Miscellaneous. In addition to the appliances already mentioned, there ould be a supply of clean cloths, scouring material, measures, and pails; fact, everything to keep the work moving evenly and to keep all equip-

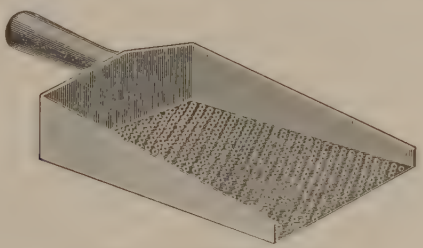

Figure 10. A Model Skimmer

ment and environment clean and sanitary. Facilities should be furnished or the quick and easy disposal of all skimmings and waste to prevent the attracting of flies and other insects about the mill.

LOCATION AND BUILDINGS

Whether a sirup factory is large or small, temporary or permanent, the best of judgment should be used in selecting its location. It should be easily accessible for bringing in the cane and fuel and should be where an abundant supply of pure water may be readily obtained for cleansing utensils and for flushing floors and drain pipes. Wherever possible the mill itself should be located at a higher elevation than the rest of the equipment. Arrangement should be such that the juice will flow from the mill to the settling tanks and from the settling tanks to the evaporator by gravity, particularly in small mills. Such arrangement will save both time and labor. In the larger mills the juice is often pumped from the receiving tank to the settling tanks on an upper floor and then flows by gravity to the evaporator. With many mills this is an added expense that may be avoided by care in the selection of a location.

All machinery and equipment should be covered, if possible to do so, to preserve it and to prevent interruptions of the work by unfavorable weather. The evaporator should, by all means, be housed. The building should have a ventilator in the top immediately above the evaporator and

of a dimension at least equal to that of the evaporator, for the escape of steam. The building should be enclosed on all sides to prevent cold drafts, which retard evaporation, from blowing over the pan. It should have very wide double doors on all sides, or the siding may be hinged at the top, in sections, in such a way as will permit them to open outward and upward in the form of an awning. These sections can then be opened in such a manner as will regulate and control the escape of steam without the admission of drafts of air.

The house should be large enough for easy passage-way between the evaporator and sides of the building; also for the easy handling of all utensils and appliances needed in the work and for storing them when not in use. Where direct heat is used for cooking it is well to partition off the fire end of the furnace from the rest of the building so that dirt and cinders may not enter the evaporator when the door of the furnace is opened for firing. The floor of the building should be of brick or cement and should be given a slight slant so as to provide for easy scrubbing and draining.

CARE IN OPERATION

Even with the most perfect equipment and appliances good sirup cannot be made unless the utmost care and attention is given to every detail of operation. The equipment will NOT run itself. No one should buy a good outfit for sirup making with the expectation that that alone will make good sirup. It takes both WORK and THOUGHT. Everything used in the process must be kept scrupulously clean.

At the end of the season the mill should be cleaned and covered. The pan, tanks, and everything about the factory should be thoroughly cleansed and put in order.

SOME QUESTIONS AND ANSWERS PERTAINING TO SORGHUM SIRUP

1. *Question:* At what stage of development should sorghum be harvested to make the best sirup?

   Answer: When the seed is in the late dough stage, just as it is hardening.

2. *Question:* How soon after harvesting should it be crushed?

   Answer: The sooner it is crushed the less danger there will be of any deterioration; but if the crop is in good condition when harvested it may safely be kept for several weeks, provided it is shocked or corded up in such a way as to prevent heating or moulding It will keep even longer if protected from sun and rain.

3. *Question:* Should the leaves be taken off before crushing?

   Answer: For a small mill, yes. For a large power mill equipped with settling tanks or other means of thoroughly cleansing the juice it is immaterial. If crushed with the leaves on it should be done while they are in a wilted condition, before they become dry enough to powder.

Question: If the leaves are stripped off, how should it be done? How long before cutting?

Answer: One of the best means is to knock off the leaves with a stick. A lath or piece of board sharpened on one side like a wooden sword makes a good utensil. Stripping should be done not more than three or four days before cutting. Experiments have shown that to do so longer than this lessens the quantity of juice.

Question: What is the effect of frost on sorghum for sirup?

Answer: If only the leaves have been injured by the frost the quality of the sirup will not be affected but it is best to harvest as soon as possible. If the stalk has been touched it must be harvested and worked up very quickly. The juice of frozen cane begins to ferment almost as soon as it begins to thaw. Consequently quick work is necessary to save it.

Question: How many tons of stripped and topped canes should an acre of sorghum yield?

Answer: From 5 to 20 tons. In North Carolina experimental demonstrations have shown an average of 14 tons of stripped and topped stalks to the acre, while in a large number of instances from 18 to 20 tons were produced. The seed heads average about 10 per cent of the total weight of the crop and the leaves another 10 per cent, so that the stripped and topped stalks average about 80 per cent. The average yield for the country at large is said to be about 10 tons per acre.

Question: How much sirup should a ton of sorghum yield?

Answer: The amount depends on the thoroughness of extraction of juice and on the amount of sucrose (sugar) in the juice. If the mill extracts 60 per cent of the weight of stalks as juice it gives 1,200 pounds of juice to the ton. If the juice has high sugar content this should yield from 15 to 24 gallons of sirup. On account of the low extraction by many mills and the low sugar content of many varieties of sorghum, the average yield per ton is about 15 gallons of sirup.

Question: How much juice does it take to make a gallon of sirup?

Answer: This, again, depends on the richness of the juice in sugar. It will range from four and a half to twelve, or possibly fourteen, gallons with an average of about eight.

Question: What is the average yield of sirup per acre?

Answer: For the United States it is about 155 gallons. For this state it is certainly not less than 200 gallons per acre where the degree of extraction is even fairly high. For the years 1919 and 1920, three varieties, Sugar Drip, Honduras, and Honey, or so called Japanese Seeded Ribbon, averaged 275.8 gallons to the acre in ten demonstrations, with a yield as high as 443 gallons to the acre in one plot.

10. *Question:* What causes sirup to "sugar out," change to sugar?

Answer: A heavy sirup that stands for a long time in a low temperature may sugar, but the principal cause is over cooking, or condensing to too low a degree. The trouble is more likely to occur in sirup made from very ripe sorghum. When very ripe the amount of crystallizable sugar in the juice is greater than at any other time, and the amount of acid which prevents crystallization is less. When sirup from an untreated juice changes to sugar it is almost entirely due to over condensation, that is, driving out too much moisture. If the finishing point is determined by the thermometer, as explained on page 14, sugaring will not often occur.

11. *Question:* What causes sirup to sour? How may it be prevented?

Answer: Insufficient cooking, unclean containers, and storing where temperature is too high. Even a little of the partially cooked juice taken into the finished sirup may bring this trouble. Cooking to the proper point of condensation, using absolutely clean containers, and storing where the temperature does not rise above 60 degrees Fahrenheit will prevent souring.

12. *Question:* What are the best containers for sirup?

Answer: For market purposes, half-gallon or gallon cans with friction tops are best. They contain about the amount that the average customer wishes to buy at one time. For home use clean jugs, fruit jars, and similar vessels that may be sealed air tight are desirable.

13. *Question:* How should sirup be stored?

Answer: It should be placed in clean containers and sealed up while still hot. It should be stored where the temperature will remain quite even. The temperature of the storage room should not ordinarily be higher than 60 degrees Fahrenheit.

14. *Question:* Is there a market for sorghum sirup?

Answer: There is always a demand for good sorghum sirup both at home and in northern places where it can not be grown. For market purposes it should always be placed in cans and the cans neatly labeled with the name of the product and name of the maker.

15. *Question:* Is the production of sorghum sirup profitable to the farmer?

Answer: Yes. An acre of sorghum should be grown for about the same cost as an acre of corn. The cost of production including harvesting and hauling to the mill should not exceed $40 per acre. An acre well cultivated should produce at least 200 gallons of sirup. At about 30 cents a gallon for making, the cost of manufacture would be $60. The sirup should sell for not less than 75 cents a gallon and probably could be retailed at a dollar or more a gallon. Consequently there should be a minimum

profit of about $50 an acre from the sirup, and if the production should run to from 300 to 400 gallons per acre, which is highly probable, the profit would be greatly increased. Besides the sirup, the seed should be worth at least $15 per acre. A net profit of at least $65 per acre should be secured from an acre of sorghum with a possibility of doubling that amount.

The following suggestions for operating evaporator pans and for building and operating brick or stone furnaces are made by one of the largest and most successful manufacturers of machinery and equipment for sorghum sirup factories. They are so practical that they should commend themselves to the careful consideration of every sirup maker who uses a pan with direct heat for cooking, and for that reason are appended here.

OPERATING SIRUP EVAPORATOR PANS

"An evaporator pan should fit the top of furnace snugly. No heat should be allowed to escape at ends or along the sides, which will damage the wooden side-rails and cause leakage. Setting an evaporator level is the best practice, although some people prefer them very slightly inclined towards chimney. The best plan to level an evaporator is to set on the furnace and put some water in it.

"When ready to begin cooking, turn juice into pan for about half of its length, having water in the rest. Do not skim the first two bars oftener than four to six times a day. Skim the other bars often and thoroughly.

"When this juice begins to slightly resemble sirup, drive out the water and turn the juice into pan for its full length. Block off the last two bars from the rest, however. Continue to cook and skim thoroughly until sirup in last two bars has reached proper consistency and purity; then draw it off, turning into these bars partially cooked juice right behind the sirup with rake or paddle. Continue the operation in this manner, and the best sirup will be produced.

"Evaporator pans are usually furnished with two or more skimmers. One of these is intended to be used exclusively in the finishing sirup; the other exclusively in the greener juice.

"The inflow of juice may be constant, if properly regulated. But the best sirup cannot be made when it is allowed to flow out constantly. Pure, high quality sirup can only be made when it is cooked and drawn off in 'runs' as above explained.

FOR BUILDING AND OPERATING BRICK OR STONE FURNACE

"A brick or stone furnace should be built about two feet high. The walls should be at least eight inches thick at bottom, but may taper to three to four inches at top. Width of furnace should not be over 40 inches outside to outside at top. If not over 38 inches, that is sufficient.

"A chimney of suitable inside diameter and height, so as to give ample draught, should be built, or a metal stack may be used. A metal bar

should be placed across furnace at each end to afford a support for ends of evaporator pan. A cast iron door should be built into furnace. They give better satisfaction than an improvised door.

"Two or more metal bars should be built into furnace eight to ten inches from bottom—the first about six inches from door. As many of these as desired may be used and placed close enough together to form a grate. Or a regular grate or grate bars may be used, in which case it will be necessary to place only one metal bar across furnace—one end of same resting on the door-frame.

"Bottom of furnace should be dug out a few inches to afford ample ash pit. The bottom of furnace should slant from back end of grate toward chimney, so that throat of furnace at chimney will be only five to eight inches deep. Top of furnace should be smooth and level along each side and across ends. A good method for levelling top of furnace is to place evaporator pan on it and then put some water in the pan. Sand or ashes should be sprinkled about half an inch deep all around top of furnace so that pan will embed itself into it, forming a tight joint so that heat will not escape or damage wooden sides of pan. Keep fire burning briskly."

The following is a list of some of the manufacturers of sorghum sirup machinery and equipment:

1. The Southern Plow Company, Columbus, Ga. Mills, open-pan evaporators, steam coil evaporators, furnaces and other appliances.
2. Blymyer Iron Works Company, Cincinnati, Ohio. Mills, open-pan evaporators, vacuum cookers, furnaces, and all kinds of sirup and sugar machinery.
3. Goldens' Foundry and Machine Co., Columbus, Ga. Mills, open-pan and steam evaporators, furnaces and steam coils.
4. Cook Cane Mill and Evaporator Company, St. Louis, Mo. Mills, evaporators and furnaces.
5. The C. S. Bell Company, Hillsboro, Ohio. Mills, furnaces and evaporators.
6. The Bahmann Iron Works Company, Dayton, Ohio. Mills, open-pan evaporators and other sirup and sugar machinery and equipment.
7. S. P. Castle & Co., Urbana, Ohio. Steam evaporators.

Manufacturers of Thermometers and Hydrometers.

1. Taylor Instrument Companies, Rochester, N. Y.
2. Eimer and Amend, New York City.